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Effect of organic substances and plant growth regulators on growth of tamarind (*Tamarindus indica* L.) Seedlings

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Abstract
Tamarind (*Tamarindus indica* L.), or Imli is also called Indian Date. It belongs to the family Leguminaceae. The use of plant growth regulators in proper concentration with scarification may regulate growth behaviour in many fruit crops and pre-sowing treatment of growth regulators could lead to increase seed germination and enhancement of seedling growth. Seed, without use of growth regulators showed poor response for germination and its growth. An experiment was carried out to identify a suitable treatment for getting better seedling growth. In the present study seeds were imposed to twelve different treatments i.e. T_0 Control (Soaking in distilled water), T_1 GA_3 @ 100 ppm, T_2 GA_3 @ 200 ppm, T_3 GA_3 @ 300 ppm, T_4 NAA @ 100 ppm for 24 hr, T_5 NAA @ 200 ppm, T_6 NAA @ 300 ppm, T_7 Acid Scarification (HCL 10%), T_8 Cow urine 5%, T_9 Cow Urine 10%, T_{10} Cow Urine 20%, T_{11} Cow Dung Slurry for 24hr and in acid 30min in Completely Randomized Design with three replications. The results reveal that among the different treatment combination T_2 GA_3 @ 200 ppm reported the highest plant growth in respect to days required for Girth of stem, Length of seedling, Root length, Number of roots/seedling, Survival percentage of seedlings were as T_3 GA_3 @ 300 ppm shows highest result in respect to days required for Number of leaves per seedling and T_1 GA_3 @ 100 ppm shows highest result for days required for Height of shoot.

Keywords: *Tamarindus indica*, GA_3, NAA, cow urine, HCL, scarification, dormancy

Introduction
Tamarind (*Tamarindus indica* L.), or Imli is also called Indian Date. It belongs to the family Leguminaceae. It is native to Tropical Africa, particularly in Sudan and also grown well in the tropical and semi-arid parts of India. India is the world's largest producer of tamarind products. In India, it is cultivated in 49,020 thousand ha area with the production of 1,90,700 MT (2016-17 Spices Board India). The major tamarind producing States are Tamil Nadu, Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh and Kerala. It is presently cultivated in home gardens, farmlands, roadsides, common lands and on a limited plantation scale in India and Thailand, where the species is economically important.

Tamarind is valued highly for its pulp used in the preparation of food and beverages for domestic and industrial purposes. The most outstanding characteristics of tamarind fruit is its acidic and sweet taste due to tartaric acid (10%) and reducing sugars (30-40%). The fruit, both ripe and dry, contains mainly tartaric acid, reducing sugars, pectin, tannin, fibre and cellulose. The whole seeds also contain protein, fat, sugars and carbohydrates. Both pulp and seeds are good sources of potassium, calcium and phosphorous and contain other minerals like sodium, zinc and iron. The acidic pulp is used in culinary preparations such as a curries, chutneys, sauces, soups etc. Fruits are having the higher content of protein, vitamin B and tartaric acid.

The use of plant growth regulators in proper concentration with scarification may regulate growth behaviour in many fruit crops and pre-sowing treatment of growth regulators could lead to increase in enhancement of seedling growth. Plant growth regulators like GA_3 and NAA enhance the germination, growth and survival of seedlings. GA_3 induced the synthesis of amylase and other hydrolytic enzymes during the early stages of seed germination. GA_3 controls mobilization of starch which acts as a respiratory substrate leading to immediate enhancement in cell elongation.

Gibberellins also help in enhancing the availability of reserved mineral elements which promote the germination process. The seed soaked in GA_3 and NAA The seed soaked in GA_3 and NAA for 12 hour resulted in high germination and shoot length. The germination of tamarind seeds is also accelerated by soaking in 10% cow urine or cow dung solution (500 g in 10 L) for 24 hours, in which germination is occurred more than doubled. The prices of growth regulators have gone sky high so to overcome this crisis some alternatives for growth regulators are easy to access and cheap.

Materials and Methods

The experiment was conducted at nursery area, Department of Horticulture, College of Agriculture, Gwalior (M.P.) under Horticulture unit during 2017-18. The topography of the area was uniform with proper drainage. The soil of the experimental field was sandy loam. The experimental field is located at an altitude of 208 meters above mean sea level 26˚ 13' N North latitude and 78˚ 14' E longitude. The experimental design selected was Completely Randomized Design. All the treatments were replicated thrice. The treatments as follows:- T_0 - Control (Soaking in distilled water) for 24 hr, T_1 - GA_3 @ 100 ppm for 24 hr, T_2 - GA_3 @ 200 ppm for 24 hr, T_3 - GA_3 @ 300 ppm for 24 hr, T_4 - NAA @ 100 ppm for 24 hr, T_5 - NAA @ 200 ppm for 24 hr, T_6 - NAA @ 300 ppm for 24 hr, T_7 - Acid Scarification (HCL 10%) for 30 min, T_8 - Cow urine 5% for 24 hr, T_9 - Cow Urine 10% for 24 hr, T_{10} - Cow Urine 20% for 24 hr, T_{11} - Cow Dung Slurry for 24 hr for the growth of tamarind seedlings. After this seeds were shade dried for 10min and then sown in Polybags of 12" x 6" (30 x 15) size filled with a mixture of soil, sand, FYM in the ratio of 2:1:1 at 0.5cm depth in 2 cm apart and were kept in the shade house and watered daily till final data were recorded. Growth parameters at definite intervals were recorded to find out the effect of these pre-treatments on Height of shoots, Number of leaves per seedling, Girth of stem, Length of seedling, Length of roots, Numbers of roots/seedling. The data collected during the investigation were analysed statistically by the method of analysis of variance. The significance of various treatments was judged and suggested by R. A. Fisher (1954) applying 'F' test.

Results and Discussion

1. Height of shoot (cm)

The height of shoot was recorded at 30, 60, 90, 120 and 150 days after sowing. The significantly maximum height of shoot 9.90, 14.73, 18.47, 30.53 and 41.70 cm respectively were recorded at successive growth stages under the treatment T_1 (GA_3 at 100 ppm for 24 hr). However, minimum heights of shoots (6.37, 10.07, 14.73, 21.00, and 31.17cm) were recorded under T_0 (Control) see in table no.1. It was due to additional GA_3, activated α-amylase which digested the available carbohydrate into simple sugar so that energy and nutrition were easily available to faster growing seedlings. Increase in plant height due to GA_3 has also been reported by Babu *et al.* (2010) [2]. In the seedlings of Cape gooseberry resulted in highest plant height which was due to GA_3 promote the growth of the plant by the promotion of cell elongation. The similar result was found by Wanyama *et al.* (2006) [16], Mishra *et al.* (2017) [7] and Kumar *et al.* (2008) [5].

2. Number of leaves per seedling

The present research reveals that the different plant growth regulators, acid scarification and organic substances show significant effect on number of leaves. The maximum mean number of leaves per seedling was observed under treatment T_3 (GA_3 at 300 ppm) i.e. 3.73, 9.33, 11.00, 15.60 and 23.30. Whereas treatment T_0 i.e. 2.97, 5.50, 7.83, 10.70 and 15.73 was recorded minimum number of leaves per seedling at all stages of observations see table no.2. The increase may be due to cell division and enhancing activity of apical meristem which may be promoted by the growth hormones. This similar results has been reported by Mishra *et al.* (2017) [7] and Pawar V.B. *et al.* (2010) [9] says that increase in number of leaves might be due to the reason that GA_3 helps in invigoration of physiological process of plant and stimulatory effect of chemicals to form new leaves at a faster rate.

3. Girth of stem (mm)

In present experiment different plant growth regulators, acid scarification and organic substances showed significant effect on girth of stem. The data about girth of stem was recorded at 30, 60, 90, 120 and 150 days after sowing. The maximum girth of stem at all stages was observed in T_2 (GA_3 at 200 ppm for 24 hr) treatment 1.93, 2.60, 2.60, 2.77 and 3.20 mm. The minimum girth was recorded 1.17, 1.40, 1.73, 1.93 and 2.20 mm under treatment T_{11} (Cow Dung Slurry for 24 hr) see table no. 3. The beneficial effect of GA_3 was probably due to cell elongation and quicker multiplication of cells after the germination. These results are in conformity with the findings of Ratan and Reddy (2004) [11], Harshavardhan and Rajasekhar (2012) [4], Chiranjeevi *et al.* (2017) [3], Vasantha *et al.* (2014) [15] and Patil *et al.* (2017) [10] they reported 200 ppm GA_3 for 24 hr show maximum stem girth in seedlings of Custard apple, Jack fruit, Aonla, Tamarind and Jamun.

4. Length of seedling (cm) at 150 days after sowing

The present research reveals that, the different plant growth regulators, acid scarification and organic substances showed significant effect on length of seedling. The length of seedling was recorded at 150 days after sowing. Maximum seedling length 67.53 cm was recorded under T_2 (GA_3 at 200 ppm for 24 hr) which was significantly superior over rest of the treatments. The minimum seedlings length 48.13 cm was recorded under control T_0 see table no.4. According to these results we conclude that gibberellins are well known for inter nodal cell elongation, thereby leading the increase in seedling length. These findings are supported by Munde and Gajbhiye (2010) [8], Patil *et al.* (2017) [10], Vasantha *et al.* (2014) [15] and Harshavardhan and Rajasekhar (2012) [4].

5. Root length at 150 days after sowing (cm)

In this study, the different plant growth regulators, acid scarification and organic substances show significant effect on root length at 150 days after sowing. The maximum root length 26.70cm was recorded under T_2 (GA_3 200 ppm for 24 hr) which was significantly superior over rest of the treatments on other side minimum root length of 17.13cm was recorded under control T_0 150 days after sowing see table no. 4. It revealed that maximum length and more number of roots observed under the treatments because it absorbed more food material and might be increased the physiological activities of seedlings, which was essential for cell division or cell enlargement or both, because growth of the plant occurs by two processes i.e. cell division by mitosis which add new cells and elongation of already existing cells by enlargement of the vacuoles. This finding was reported by Swamy *et al.* (1999) [13], Ramteke V. *et al.* (2015) [12] and Kalabandi *et al.* (2003) [6].

6. Number of roots/seedling at 150 days after sowing

In the current experiment different plant growth regulators, acid scarification and organic substances show significant effect on number of roots/seedling. Maximum number of 64.87 roots per seedling was recorded under T_2 (GA_3 200 ppm for 24hr) followed by (62.67) in T_3 (GA_3 at 300 ppm) whereas, minimum number of 38.97 root was recorded under control T_0 see table no.4. Hence, vigorous root growth due to GA_3 might have resulted in more production of photosynthesis and their translocation through phloem to the root zone, which might be responsible for improving the root growth. Similar findings were seen by Al-Hawezy Shabaq Muhamad Nafea (2013) [1], Suradinata Y.R. *et al.* (2017) [14] and Patil *et al.* (2017) [10].

Conclusion

From the present investigation, it was concluded that, Girth of stem, Length of seedling, Length of roots, Numbers of roots/seedling. was noticed in seedling subjected to application of GA_3 200 ppm for 24 hr. were as Height of shoots was noticed superior under T_1 (GA_3 at 100 ppm for 24hr) and Number of leaves per seedling was noticed superior under T_3 (GA_3 at 300 ppm). Finally, it is concluded that the plant growth regulator (GA_3 200 ppm) was found superior over rest of the plant growth regulators and cow urine, under study, which was significantly influenced the growth of seedling It affect significantly all the recorded parameters. As regards GA_3 is significantly encourage to growth of tamarind seedlings. GA_3 induced the synthesis of amylase and other hydrolytic enzymes during the early stages of seed germination. GA_3 controls mobilization of starch which acts as a respiratory substrate leading to immediate enhancement in cell elongation.

Table 1: Effect of organic substance, scarification and plant growth regulators on height of shoot

Treatment	Treatment details	Height of shoot (cm)				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
T_0	Control (Soaking in distilled water) for 24 hr.	6.37	10.07	14.73	21.00	31.17
T_1	GA_3 @ 100 ppm for 24 hr.	9.90	14.73	18.47	30.53	41.70
T_2	GA_3 @ 200 ppm for 24 hr.	9.40	14.30	18.27	28.33	41.23
T_3	GA_3 @ 300 ppm for 24 hr.	9.27	14.17	18.00	28.07	41.20
T_4	NAA @ 100 ppm for 24 hr.	8.70	13.33	17.23	26.97	37.83
T_5	NAA @ 200 ppm for 24 hr.	8.33	13.47	17.50	28.00	38.57
T_6	NAA @ 300 ppm for 24 hr.	8.30	13.67	17.07	28.47	37.37
T_7	Acid Scarification (HCl 10%) for 30 min.	7.70	12.67	16.40	25.27	35.47
T_8	Cow urine 5% for 24 hr.	7.63	12.30	15.20	24.20	34.23
T_9	Cow Urine 10% for 24 hr.	7.33	11.53	15.80	24.60	34.37
T_{10}	Cow Urine 20% for 24 hr.	7.07	11.47	15.40	24.00	34.13
T_{11}	Cow Dung Slurry for 24 hr.	6.97	11.23	15.13	22.90	33.13
S.Em±		0.119	0.133	0.179	0.405	0.414
CD at 5%		0.349	0.387	0.522	1.183	1.209

Table 2: Effect of organic substance, scarification and plant growth regulators on number of leaves per seedling at 30, 60, 90, 120 and 150 days after sowing

Treatment	Treatment details	Number of leaves per seedling				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
T_0	Control (Soaking in distilled water) for 24 hr.	2.97	5.50	7.83	10.70	15.73
T_1	GA_3 @ 100 ppm for 24 hr.	3.43	9.00	10.83	13.50	21.60
T_2	GA_3 @ 200 ppm for 24 hr.	3.57	8.87	10.50	14.77	22.70
T_3	GA_3 @ 300 ppm for 24 hr.	3.73	9.33	11.00	15.67	23.30
T_4	NAA @ 100 ppm for 24 hr.	3.43	8.03	9.33	12.70	20.53
T_5	NAA @ 200 ppm for 24 hr.	3.43	8.73	9.43	13.70	20.73
T_6	NAA @ 300 ppm for 24 hr.	3.57	8.83	9.40	13.70	21.30
T_7	Acid Scarification (HCl 10%) for 30 min.	3.23	7.80	8.27	11.67	19.30
T_8	Cow urine 5% for 24 hr.	3.33	7.03	8.47	11.77	18.47
T_9	Cow Urine 10% for 24 hr.	3.40	6.47	8.70	12.17	18.73
T_{10}	Cow Urine 20% for 24 hr.	3.20	6.73	8.13	12.23	18.70
T_{11}	Cow Dung Slurry for 24 hr.	3.23	6.30	8.07	11.27	17.67
S.Em±		0.115	0.205	0.119	0.116	0.112
CD at 5%		0.335	0.599	0.346	0.338	0.326

Table 3: Effect of organic substance, scarification and plant growth regulators on girth of stem (mm) at 30, 60, 90, 120 and 150 days after sowing

Treatment	Treatment details	Girth of stem (mm)				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
T_0	Control (Soaking in distilled water) for 24 hr.	1.33	1.60	2.10	2.23	2.37
T_1	GA_3 @ 100 ppm for 24 hr.	1.87	2.50	2.47	2.77	2.87
T_2	GA_3 @ 200 ppm for 24 hr.	1.93	2.60	2.60	2.77	3.20
T_3	GA_3 @ 300 ppm for 24 hr.	1.73	2.47	2.73	2.80	3.00
T_4	NAA @ 100 ppm for 24 hr.	1.43	2.07	2.20	2.57	2.67
T_5	NAA @ 200 ppm for 24 hr.	1.60	1.87	2.33	2.60	2.70
T_6	NAA @ 300 ppm for 24 hr.	1.53	1.67	2.37	2.63	2.77

T_7	Acid Scarification (HCl 10%) for 30 min.	1.33	1.53	2.17	2.30	2.47
T_8	Cow urine 5% for 24 hr.	1.30	1.57	2.03	2.40	2.50
T_9	Cow Urine 10% for 24 hr.	1.33	1.47	2.20	2.23	2.30
T_{10}	Cow Urine 20% for 24 hr.	1.23	1.40	1.93	2.10	2.30
T_{11}	Cow Dung Slurry for 24 hr.	1.17	1.40	1.73	1.93	2.20
S.Em±		0.059	0.053	0.057	0.057	0.054
CD at 5%		0.171	0.154	0.166	0.166	0.159

Table 4: Effect of organic substance, scarification and plant growth regulators on Length of seedling (cm) at 150 days, Root length at 150 days and number of roots per seedling at 150 days after sowing

Treatment	Treatment details	Length of seedling (cm) at 150 days	Root length at 150 days	Number of roots/seedling at 150 days
T_0	Control (Soaking in distilled water) for 24 hr.	48.13	17.13	38.97
T_1	GA_3 @ 100 ppm for 24 hr.	65.40	24.50	60.33
T_2	GA_3 @ 200 ppm for 24 hr.	67.53	26.70	64.87
T_3	GA_3 @ 300 ppm for 24 hr.	66.52	25.53	62.67
T_4	NAA @ 100 ppm for 24 hr.	59.44	21.10	56.53
T_5	NAA @ 200 ppm for 24 hr.	61.39	23.10	55.03
T_6	NAA @ 300 ppm for 24 hr.	59.28	22.07	57.93
T_7	Acid Scarification (HCl 10%) for 30 min.	57.41	21.57	51.00
T_8	Cow urine 5% for 24 hr.	52.01	17.20	49.37
T_9	Cow Urine 10% for 24 hr.	54.95	20.70	45.40
T_{10}	Cow Urine 20% for 24 hr.	54.75	20.53	47.87
T_{11}	Cow Dung Slurry for 24 hr.	52.60	19.37	41.03
S.Em±		0.610	0.591	0.407
CD at 5%		1.781	1.725	1.187

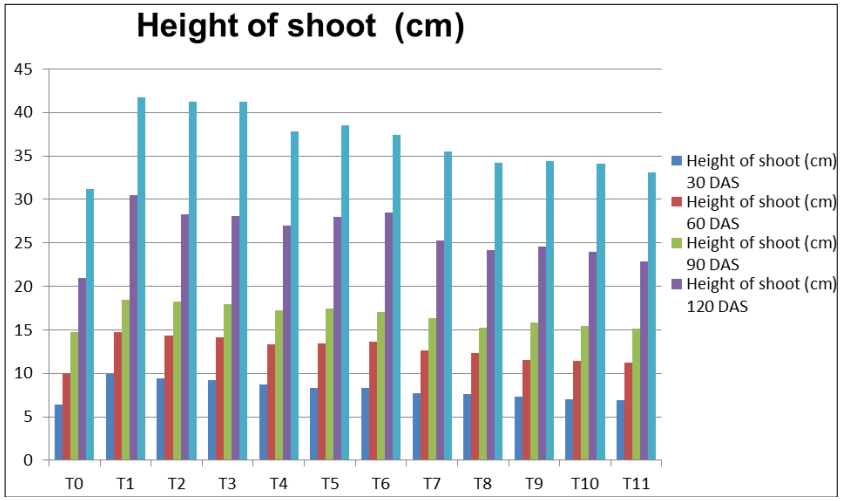

Fig 1: Effect of organic substance, scarification and plant growth regulators on height of shoot

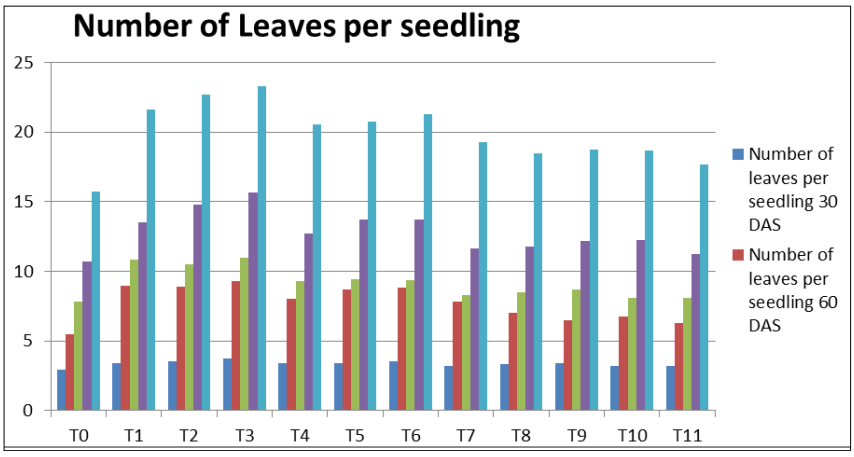

Fig 2: Effect of organic substance, scarification and plant growth regulators on number of leaves per seedling at 30, 60, 90, 120 and 150 days after sowing

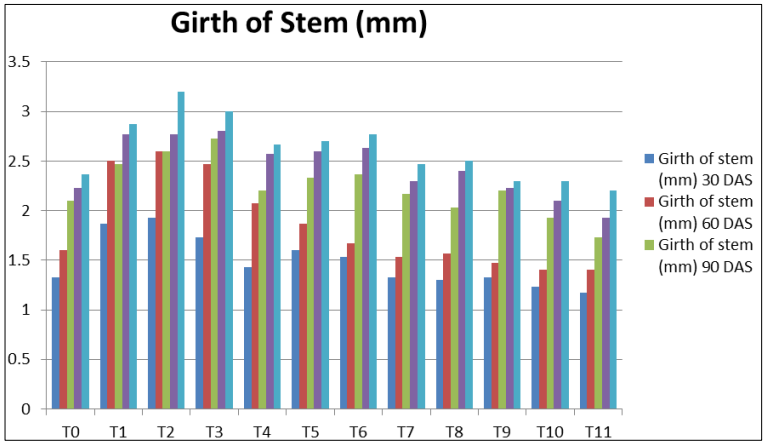

Fig 3: Effect of organic substance, scarification and plant growth regulators on girth of stem (mm) at 30, 60, 90, 120 and 150 days after sowing

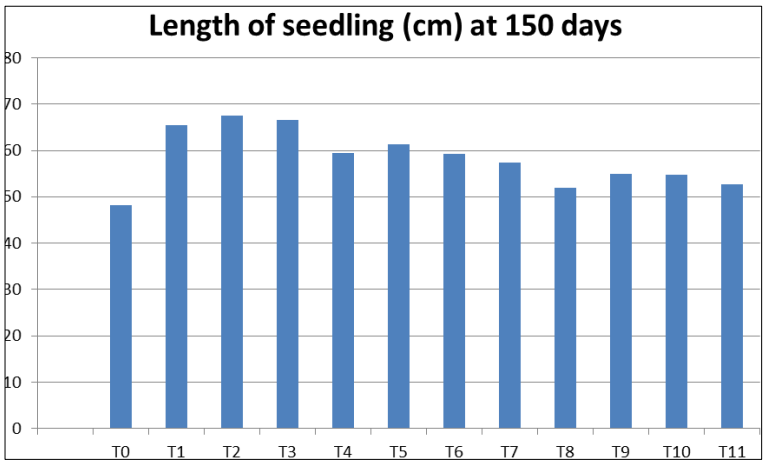

Fig 4: Effect of organic substance, scarification and plant growth regulators on length of seedling (cm) at 150 days after sowing

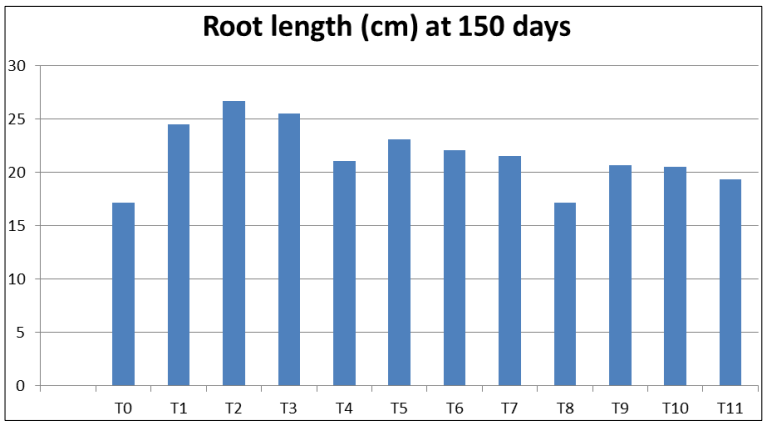

Fig 5: Effect of organic substance, scarification and plant growth regulators on root length (cm) at 150 days after sowing

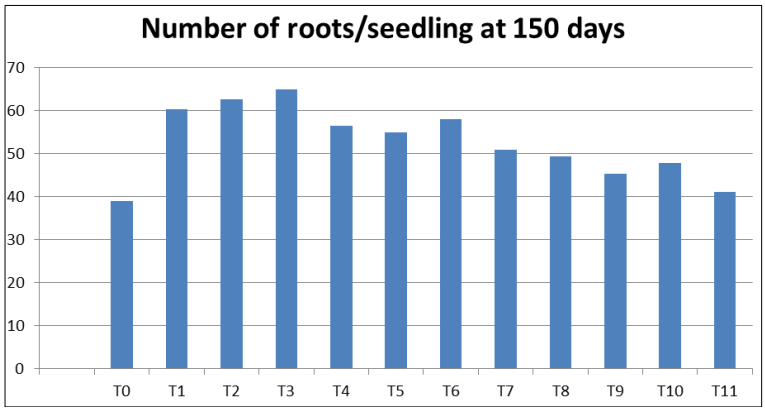

Fig 6: Effect of organic substance, scarification and plant growth regulators on number of roots per seedling at 150 days after sowing

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